Energy and system-size dependence of neutral mesons production at the Large Hadron Collider with ALICE

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Introduction

The measurement of $\pi^0$ and $\eta$ mesons spectra in a wide $p_T$ range is important to characterise particle production mechanisms. In pp collisions it provides a test of perturbative quantum chromodynamics (pQCD) predictions and allows to constrain parton distribution functions (PDF) and fragmentation functions (FF). In heavy-ion collisions it allows to study parton energy loss in the hot and dense medium. Such a medium, comprised of deconfined quarks and gluons, is known as Quark-Gluon Plasma. The neutral meson spectra measured in p-Pb collisions are important to study cold nuclear effects, and to disentangle suppression originating from initial state effects in the colliding nuclei from final state effects in the Pb-Pb collisions. The low $p_T$ of the neutral meson spectra measured in p-Pb and Pb-Pb collisions is sensitive to the collective flow effects.

![Invariant mass spectrum of photon candidates around the $\pi^0$ mass (left) and $\eta$ mass (right).](image)

FIG. 1: Invariant mass spectrum of photon candidates around the $\pi^0$ mass (left) and $\eta$ mass (right).

![Invariant cross-section of $\pi^0$ (left) and $\eta$ meson (right) production at midrapidity in pp collisions at different LHC energies, compared to PYTHIA 8 and NLO pQCD predictions. Error bars represent statistical and boxes systematic uncertainties. Bottom panel show ratio of measured $\pi^0$ ($\eta$ meson) production cross-sections and theoretical calculations to the fit to data.](image)

FIG. 2: Invariant cross-section of $\pi^0$ (left) and $\eta$ meson (right) production at midrapidity in pp collisions at different LHC energies, compared to PYTHIA 8 and NLO pQCD predictions. Error bars represent statistical and boxes systematic uncertainties. Bottom panel show ratio of measured $\pi^0$ ($\eta$ meson) production cross-sections and theoretical calculations to the fit to data.

Measurement of $\pi^0$ and $\eta$ mesons

In the ALICE experiment at the CERN LHC neutral mesons are reconstructed by two-photon invariant mass analysis. Photons are measured in the electromagnetic calorimeters, EMCal and PHOS, or reconstructed as $e^+e^-$ pair created by the photon conversion in material of central tracking detectors. The two-photon candidates invariant mass distribution in PHOS is shown in Fig.1. The large acceptance and good momentum resolution of the

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tracking system help to measure the π^0 up to very low p_T, whereas good energy resolution of calorimeters and trigger capability allows π^0 measurement at high p_T. Results from different techniques are combined to provide precise measurements of π^0 and η mesons in pp collisions over a very wide p_T range.

**Results**

In ALICE, π^0 is measured in pp collisions at several collision energies √s = 0.9, 2.76, 5, 7 and 8 TeV [1–3] as shown in Fig.2 (left). The results are compared with predictions from PYTHIA 8 Monash Tune and NLO pQCD calculations. The bottom part of the panel shows the ratio of data and theory predictions to the fit to data with a two-component model function. PYTHIA 8 approximately reproduces the data, while NLO pQCD calculations overestimate the data by 20-30% at all colliding energies. η mesons cross-section is also measured in all these energies [1–3], as shown in Fig.2 (right). PYTHIA 8 agrees with the experimental measurement whereas NLO pQCD predictions overestimate the η yield similar to π^0. Furthermore, the η/π^0 ratio does not show any multiplicity dependence and is consistent with the pp results.

Neutral mesons nuclear modification factors Q_pA show multiplicity dependence for CL1 multiplicity estimator based on tracks with |η| < 1.4, shown in Fig.3. The Q_pA for π^0, η and D-meson agree with each other but unidentified charged particles show increase at p_T ∼ 3 GeV/c. The η/π^0 ratio does not show any multiplicity dependence and is consistent with the pp results.

Neutral mesons nuclear modification factors R_AAA are measured in Pb-Pb collisions at √s_{NN} = 2.76 and 5.02 TeV by ALICE. The R_AAA for π^0 depends on centrality and is the lowest for central collisions, shown in Fig.4, which represents the strongest suppression [4, 5]. In this talk, an overview of neutral mesons production at the ALICE experiment is presented for different collision systems at different centre-of-mass energies. Results from Q_pA and R_AAA for neutral mesons with heavy flavour and charged particles at the LHC energies are compared.

**References**